

Apprenticeship and Industry Training

Welder

Apprenticeship Course Outline

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Alberta



Apprenticeship and
Industry Training

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Apprenticeship

Apprenticeship is post-secondary education with a difference. Apprenticeship begins with finding an employer. Employers hire apprentices, pay their wages and provide on-the-job training and work experience. Approximately 80 per cent of an apprentice's time is spent on the job under the supervision of a certified journeyperson or qualified tradesperson. The other 20 per cent involves technical training provided at, or through, a post-secondary institution – usually a college or technical institute.

To become certified journeypersons, apprentices must learn theory and skills, and they must pass examinations. Requirements for certification—including the content and delivery of technical training—are developed and updated by the Alberta Apprenticeship and Industry Training Board on the recommendation of Welder Provincial Apprenticeship Committee.

The graduate of the Welder apprenticeship program is a certified journeyperson who will be able to:

- be skilful in the fusing of metals using prescribed welding applications
- have a working knowledge of the welding equipment involved with the various welding procedures
- comprehend drawings and develop layout patterns for projects and calculate quantities of materials
- have a thorough knowledge of metals, arc electrodes, welding gases and gas welding filler rods
- recognize defective welds; know the cause and proper procedure for the repair of the defective area
- have a working knowledge of mathematics calculations pertaining to the welding trade
- have a working knowledge of the required codes
- be familiar with the work of other trades people in affiliated trades
- perform assigned tasks in accordance with quality and production standards required by industry

Apprenticeship and Industry Training System

Industry-Driven

Alberta's apprenticeship and industry training system is an industry-driven system that ensures a highly skilled, internationally competitive workforce in more than 50 designated trades and occupations. This workforce supports the economic progress of Alberta and its competitive role in the global market. Industry (employers and employees) establishes training and certification standards and provides direction to the system through an industry committee network and the Alberta Apprenticeship and Industry Training Board. The Alberta government provides the legislative framework and administrative support for the apprenticeship and industry training system.

Alberta Apprenticeship and Industry Training Board

The Alberta Apprenticeship and Industry Training Board provides a leadership role in developing Alberta's highly skilled and trained workforce. The board's primary responsibility is to establish the standards and requirements for training and certification in programs under the Apprenticeship and Industry Training Act. The board also provides advice to the Minister of Advanced Education and Technology on the needs of Alberta's labour market for skilled and trained workers, and the designation of trades and occupations.

The thirteen-member board consists of a chair, eight members representing trades and four members representing other industries. There are equal numbers of employer and employee representatives.

Industry Committee Network

Alberta's apprenticeship and industry training system relies on a network of industry committees, including local and provincial apprenticeship committees in the designated trades, and occupational committees in the designated occupations. The network also includes other committees such as provisional committees that are established before the designation of a new trade or occupation comes into effect. All trade committees are composed of equal numbers of employer and employee representatives. The industry committee network is the foundation of Alberta's apprenticeship and industry training system.

Local Apprenticeship Committees (LAC)

Wherever there is activity in a trade, the board can set up a local apprenticeship committee. The board appoints equal numbers of employee and employer representatives for terms of up to three years. The committee appoints a member as presiding officer. Local apprenticeship committees:

- monitor apprenticeship programs and the progress of apprentices in their trade, at the local level
- make recommendations to their trade's provincial apprenticeship committee (PAC) about apprenticeship and certification in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- make recommendations to the board about the appointment of members to their trade's PAC
- help settle certain kinds of disagreements between apprentices and their employers
- carry out functions assigned by their trade's PAC or the board

Provincial Apprenticeship Committees (PAC)

The board establishes a provincial apprenticeship committee for each trade. It appoints an equal number of employer and employee representatives, and, on the PAC's recommendation, a presiding officer - each for a maximum of two terms of up to three years. Most PACs have nine members but can have as many as twenty-one. Provincial apprenticeship committees:

- Make recommendations to the board about:
 - standards and requirements for training and certification in their trade
 - courses and examinations in their trade
 - apprenticeship and certification
 - designation of trades and occupations
 - regulations and orders under the Apprenticeship and Industry Training Act
- monitor the activities of local apprenticeship committees in their trade
- determine whether training of various kinds is equivalent to training provided in an apprenticeship program in their trade
- promote apprenticeship programs and training and the pursuit of careers in their trade
- consult with other committees under the Apprenticeship and Industry Training Act about apprenticeship programs, training and certification and facilitate cooperation between different trades and occupations
- consult with organizations, associations and people who have an interest in their trade and with employers and employees in their trade
- may participate in resolving certain disagreements between employers and employees
- carry out functions assigned by the board

Welder PAC Members at the Time of Publication

Mr. I. Furber	Edmonton	Presiding Officer
Mr. L. Burns	Calgary	Employer
Mr. R. Wright	Edmonton	Employer
Mr. R. Golosky	Ft. McMurray	Employer
Mr. T. Stewart	Hinton	Employer
Mr. D. Bohle	Lethbridge	Employer
Mr. L. Millington	Medicine Hat	Employer
Mr. L. Kragnes	Vermilion	Employer
Mr. P. Gerlinsky	Bonnyville	Employee
Mr. A. Hindle	Calgary	Employee
Mr. J. Gras	Edmonton	Employee
Mr. B. Pruden	Edmonton	Employee
Mr. T. Major	Ft. McMurray	Employee
Mr. R. Frederiksen	Medicine Hat	Employee
Mr. M. Moxness	Red Deer	Employee

Alberta Government

Alberta Advanced Education and Technology works with industry, employer and employee organizations and technical training providers to:

- facilitate industry's development and maintenance of training and certification standards
- provide registration and counselling services to apprentices and employers
- coordinate technical training in collaboration with training providers
- certify apprentices and others who meet industry standards

Technical Institutes and Colleges

The technical institutes and colleges are key participants in Alberta's apprenticeship and industry training system. They work with the board, industry committees and Alberta Advanced Education and Technology to enhance access and responsiveness to industry needs through the delivery of the technical training component of apprenticeship programs. They develop lesson plans from the course outlines established by industry and provide technical training to apprentices.

Apprenticeship Safety

Safe working procedures and conditions, incident/injury prevention, and the preservation of health are of primary importance in apprenticeship programs in Alberta. These responsibilities are shared and require the joint efforts of government, employers, employees, apprentices and the public. Therefore, it is imperative that all parties are aware of circumstances that may lead to injury or harm.

Safe learning experiences and healthy environments can be created by controlling the variables and behaviours that may contribute to or cause an incident or injury. By practicing a safe and healthy attitude, everyone can enjoy the benefit of an incident and injury free environment.

Alberta Apprenticeship and Industry Training Board Safety Policy

The Alberta Apprenticeship and Industry Training Board fully supports safe learning and working environments and encourages the teaching of proper safety procedures both within trade specific training and in the workplace.

Trade specific safety training is an integral component of technical training, while ongoing or general non-trade specific safety training remains the responsibility of the employer and the employee as required under workplace health and safety legislation.

Workplace Responsibilities

The employer is responsible for:

- training employees and apprentices in the safe use and operation of equipment
- providing and maintaining safety equipment, protective devices and clothing
- enforcing safe working procedures
- providing safeguards for machinery, equipment and tools
- observing all accident prevention regulations

The employee and apprentice are responsible for:

- working in accordance with the safety regulations pertaining to the job environment
- working in such a way as not to endanger themselves, fellow employees or apprentices

Workplace Health and Safety

A tradesperson is often exposed to more hazards than any other person in the work force and therefore should be familiar with and apply the Occupational Health and Safety Act, Regulations and Code when dealing with personal safety and the special safety rules that apply to all daily tasks

Workplace Health and Safety (Alberta Employment, Immigration and Industry) conducts periodic inspections of workplaces to ensure that safety regulations for industry are being observed.

Additional information is available at www.worksafely.org

Technical Training

Apprenticeship technical training is delivered by the technical institutes and many colleges in the public post-secondary system throughout Alberta. The colleges and institutes are committed to delivering the technical training component of Alberta apprenticeship programs in a safe, efficient and effective manner. All training providers place great emphasis on safe technical practices that complement safe workplace practices and help to develop a skilled, safe workforce.

The following institutions deliver Welder apprenticeship technical training:

Medicine Hat College	Lakeland College
Keyano College	Red Deer College
Northern Alberta Institute of Technology	Lethbridge College
Southern Alberta Institute of Technology	Northern Lakes College (Slave Lake)
Northern Alberta Institute of Technology (Fairview)	Portage College (Lac La Biche)
Olds College	

Procedures for Recommending Revisions to the Course Outline

Advanced Education and Technology has prepared this course outline in partnership with the Welder Provincial Apprenticeship Committee.

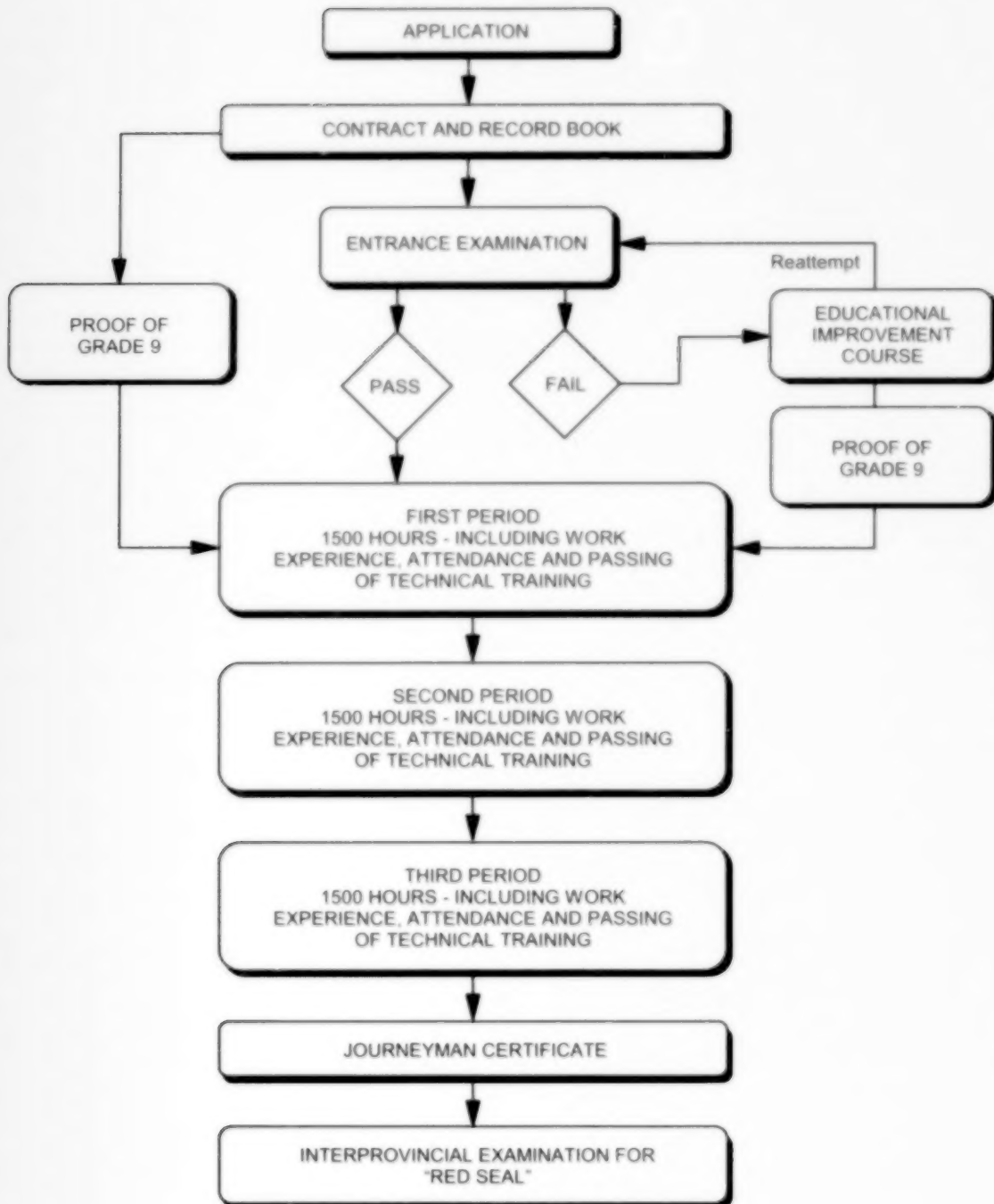
This course outline was approved on December 11, 2006 by the Alberta Apprenticeship and Industry Training Board on a recommendation from the Provincial Apprenticeship Committee. The valuable input provided by representatives of industry and the institutions that provide the technical training is acknowledged.

Any concerned individual or group in the province of Alberta may make recommendations for change by writing to:

Welder Provincial Apprenticeship Committee
c/o Industry Programs and Standards
Apprenticeship and Industry Training
Advanced Education and Technology
10th floor, Commerce Place
10155 102 Street NW
Edmonton AB T5J 4L5

It is requested that recommendations for change refer to specific areas and state references used. Recommendations for change will be placed on the agenda for regular meetings of the Welder Provincial Apprenticeship Committee.

Apprenticeship Route toward Certification



Welder Training Profile
FIRST PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

**SAFETY, TOOLS, WELD
FAULTS AND OAW**

56 HOURS



A		B		C	
Welder Apprenticeship Program Orientation		Safety Guidelines		Welding Safety	
120101a	2 Hours	120101b	4 Hours	120101c	4 Hours
D		E		F	
Hand Tools		Power Tools		Weld Faults	
120101d	2 Hours	120101e	5 Hours	120101f	5 Hours
G		H		I	
Oxy-Fuel Equipment		Oxy-Fuel Brazing		Oxy-Fuel Cutting	
120101g	4 Hours	120101h	8 Hours	120101i	12 Hours
J					
Materials Handling					
120101j	10 Hours				

SECTION TWO

SMAW ONE

81 HOURS



A		B		C	
SMAW Equipment		Mild Steel Electrodes		Basic Joint and Weld Types	
120102a	6 Hours	120102b	3 Hours	120102c	4 Hours
D		E			
Shop/Lab Practices: SMAW Welds on Mild Steel		Arc Cutting and Gouging			
120102d	65 Hours	120102e	3 Hours		

SECTION THREE

GMAW, FCAW AND SAW

73 HOURS



A		B		C	
Gas Metal Arc Welding (GMAW) - Equipment		GMAW Filler Metals, Shielding Gases and Safety		GMAW, Equipment and Troubleshooting	
120103a	4 Hours	120103b	4 Hours	120103c	7 Hours
D		E		F	
Flux Cored Arc Welding (FCAW)		Submerged Arc Welding (SAW)		Shop / Lab Practices: GMAW Welds on Mild Steel	
120103d	4 Hours	120103e	5 Hours	120103f	30 Hours
G		H			
Shop / Lab Practices: FCAW Welds on Mild Steel		Shop / Lab Practices Combined GMAW and FCAW Welds on Mild Steel			
120103g	14 Hours	120103h	5 Hours		

SECTION FOUR

TRADE MATHEMATICS

30 HOURS



A		B		C	
Fractions		Decimals		Percentage and Ratios	
120104a	4 Hours	120104b	4 Hours	120104c	5 Hours
D		E			
Geometric Formulas		Metric and Imperial Measure			
120104d	12 Hours	120104e	5 Hours		

SECOND PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

SMAW TWO

110 HOURS



A	B	C
SMAW Groove Welds on Grey Cast Iron 120201a 2 Hours	Production and Properties of Metals 120201b 6 Hours	Carbon & Alloy Steels and Alloy Steel Filler Metals 120201c 8 Hours
D	E	F
Metal Identification 120201d 2 Hours	Distortion 120201e 3 Hours	Hardfacing 120201f 3 Hours
G		
SMAW Welds on Mild Steel 120201g 86 Hours		

SECTION TWO

GTAW ONE GMAW and FCAW TWO

64 HOURS



A	B	C
Introduction to GTAW Process 120202a 2 Hours	GTAW Electrodes, Filler Metals, and Shielding Gases 120202b 4 Hours	GTAW Equipment Maintenance and Troubleshooting 120202c 3 Hours
D	E	F
GTAW Welds on Mild Steel 120202d 18 Hours	Aluminum and Aluminum Welding 120202e 8 Hours	GTAW Welds on Aluminum 120202f 6 Hours
G	H	I
GTAW Welds on Stainless Steel 120202g 6 Hours	GMAW Welds on Aluminum 120203a 2 Hours	GMAW, SMAW and FCAW Welds on Mild Steel Pipe 120203b 15 Hours

SECTION THREE

PATTERN DEVELOPMENT AND DRAWING INTERPRETATION

66 HOURS



A	B	C
Introduction to Pattern Development 120204a 6 Hours	Geometric Construction 120204b 14 Hours	Isometric and Oblique Drawings 120204c 6 Hours
D	E	F
Basic Fabrication Layout Practice 120204d 10 Hours	Plate Layout 120204e 8 Hours	Pipe Layout 120204f 6 Hours
G	H	
Welding Symbols 120204g 10 Hours	Estimating 120204h 6 Hours	

THIRD PERIOD
(8 Weeks 30 Hours per Week – Total of 240 Hours)

SECTION ONE

SMAW THREE

116 HOURS



A

Stainless Steels

120301a

6 Hours

B

Nickel Alloys and Clad Steels

120301b

2 Hours

C

SMAW Welds and Oxy-Fuel
Cutting on Mild Steel

120301c

80 Hours

D

SMAW Welds on Mild Steel
Plate and Pipe

120301d

30 Hours

SECTION TWO

GTAW TWO

28 HOURS



A

GTAW Welds on Mild Steel
Plate and Pipe

120102a

6 Hours

SECTION THREE

DRAWING INTERPRETATION

58 HOURS



A

Introduction to Drawing
Interpretation

120303a

12 Hours

B

Structural Drawings

120303b

14 Hours

C

Piping Drawings

120303c

16 Hours

D

Pressure Vessel Drawings

120303d

16 Hours

SECTION FOUR

TRADE SCIENCE

36 HOURS



A

Non-Destructive Testing

120304a

4 Hours

B

Destructive Testing

120304b

8 Hours

C

Metallurgy

120304c

7 Hours

D

Heat Treatment

120304d

6 Hours

E

Codes and Standards

120304e

10 Hours

F

Apprenticeship and Industry
Training – Industry Network

1 Hour

NOTE: The hours stated are for guidance and should be adhered to as closely as possible. However, adjustments must be made for rate of apprentice learning, statutory holidays, registration and examinations for the training establishment and Apprenticeship and Industry Training.

**FIRST PERIOD TECHNICAL TRAINING
WELDER TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE: SAFETY, TOOLS, WELD FAULTS AND OAW 56 HOURS

A. Welder Apprenticeship Training Program Orientation (120101a) 2 Hours

Outcome: *Describe the responsibilities and opportunities in the welding trade.*

1. Describe the apprenticeship training system in Alberta.
2. Identify the training profile of Welding Apprenticeship in Alberta.
3. Explain the Welder program outline learning outcomes and objectives.
4. Describe the responsibilities for the Contract of Apprenticeship by the apprentice, employer and Alberta Apprenticeship and Industry Training.
5. Identify industrial, commercial and construction fields that provide employment opportunities for welders.
6. Discuss the contents of the apprenticeship training Record Book.
7. Demonstrate the ability to complete an acceptable resume.

B. Safety Guidelines (120101b) 4 Hours

Outcome: *Follow O H & S and WHMIS guidelines.*

1. Describe applications of the Workers' Compensation Act in the work place.
2. Demonstrate an ability to locate and interpret sections of the Occupational Health and Safety Act, General Safety Regulations as they apply to welding.
3. Explain the WHMIS program.
4. Describe the procedure for welding or cutting in confined spaces or on potentially dangerous enclosures.

C. Welding Safety (120101c) 4 Hours

Outcome: *Apply safe work practices and procedures when using welding and cutting equipment.*

1. Identify physical hazards that are common to welding and cutting equipment.
2. Identify use of personal protective equipment for welding and cutting operations.
3. Identify fire hazards and methods of fire.
4. Explain the hazards involved with welding fumes and gases.
5. Identify welding fume ventilation methods.
6. Identify use of personal protective equipment for hazardous and toxic materials.
7. Explain the effects of electricity and precautions used to prevent injury.

D. Hand Tools (120101d).....2 Hours**Outcome:** *Use hand tools.*

1. Describe safety precautions for hand tools.
2. Identify the layout and measuring tools and their uses.
3. Identify clamping tools and their uses.
4. Identify cutting tools and their uses.
5. Identify the other hand tools used by welders.

E. Power Tools (120101e).....5 Hours**Outcome:** *Use power tools.*

1. Describe and demonstrate the safe operation of bench and pedestal grinders, angle and straight grinders.
2. Describe and demonstrate the use and safe operation of portable power drills, drill presses and twist drills.
3. Describe the use and safe operation of metal forming, and shaping tools.
4. Identify and describe the procedures for cutting metals using shearing machines, power cut-off saws, and metal-cutting band saws.

F. Weld Faults (120101f).....5 Hours**Outcome:** *Identify the cause of faults in welds and methods for their prevention.*

1. Define the major classifications of weld faults.
2. Define notching effect.
3. Identify basic weld faults, their causes, and ways to avoid them.

G. Oxy-Fuel Equipment (120101g).....4 Hours**Outcome:** *Assemble oxy-fuel equipment.*

1. Describe the characteristics and handling procedures for oxygen and fuel gases.
2. Describe the functions of oxy-fuel equipment components.
3. Describe the use, care and maintenance of oxy-fuel equipment components.
4. Explain the recommended procedure for placement, set-up and shutting down the equipment.
5. Identify causes and preventive measures for backfires, flashbacks and burn backs.
6. Describe pressure and flame adjustments.

H. Oxy-Fuel Brazing (120101h).....8 Hours**Outcome:** *Perform oxy-fuel welding, braze welding and brazing.*

1. Describe filler rods and fluxes.
2. Demonstrate the ability to weld lap joints on 10 Ga. or 11 Ga. (3.00 - 3.25 mm) mild steel in the 2F and 3F position using a braze welding filler material.

I. Oxy-Fuel Cutting (120101i).....12 Hours**Outcome: *Perform oxy-fuel cutting.***

1. Demonstrate the ability to safely operate a hand-held oxy-fuel cutting torch on available plate and structural shapes.
2. Perform straight line, bevel, and cutting on available mild steel.
3. Pierce and cut holes in mild steel plate.
4. Cope 3/8" mild steel plate to fit a 4" channel member.
5. Demonstrate the ability to safely operate an oxy-fuel cutting machine torch on available plate.

J. Materials Handling (120101j).....10 Hours**Outcome: *Apply safe materials handling procedures.***

1. Identify safe procedures for handling and storing materials.
2. Determine weight and centre of gravity of loads.
3. Describe the effect that sling angles have on safe lifting.
4. Be able to identify the load limits of commonly used wire rope and synthetic slings.
5. Describe the causes and effects of shock loading on rigging.
6. Identify Occupational Health and Safety Regulations regarding safety factors.
7. Identify and use hand signals for crane operations.
8. Describe safe procedures for lifting, hoisting or moving loads.
9. Describe the care and use of wire rope, synthetic rope and chains.
10. Describe the correct use of plate clamps.
11. Describe the correct procedure for applying wire rope clips.

SECTION TWO:SMAW ONE 81 HOURS**A. SMAW Equipment (120102a).....6 Hours****Outcome: *Identify SMAW equipment.***

1. Define SMAW related terms.
2. Describe AC and AC-DC rectified welding power sources.
3. Describe AC-DC generator welding power sources.
4. Describe multi process inverter welding power sources.
5. Identify welding cables and accessories for welding power sources.
6. Identify the effect of arc length on amperage and voltage.

B. Mild Steel Electrodes (120102b)3 Hours**Outcome:** *Select mild steel electrodes for SMAW.*

1. Identify and define the terms associated with SMAW electrodes.
2. Identify the CSA and AWS classification and specifications for SMAW electrodes.
3. Identify the types and functions of SMAW electrode coatings.
4. Describe the functions of the slag.
5. Describe basic care, handling and storage procedures for these electrodes.
6. Identify commonly used mild steel SMAW electrodes and their applications.

C. Basic Joint and Weld Types (120102c).....4 Hours**Outcome:** *Identify basic joints and weld types.*

1. Identify the five basic joints.
2. Describe the types of welds and their acceptable dimensions.
3. Identify joint and weld type variations.
4. Outline the major considerations to be accounted for in the design of a joint for welding.

D. Shop/Lab Practices: SMAW Welds on 3/8" Mild Steel Plate (120102d).....65 Hours**Outcome:** *Perform surface welds in the flat position.**Perform 1F welds using SMAW.**Perform 2F welds using SMAW.**Perform 3F welds using SMAW.**Perform 1G welds using SMAW.**Perform 1GF welds using SMAW.*

1. Demonstrate the ability to weld surface welds (stringer beads) in the flat position using E4914, E4310 and E4918 electrodes.
2. Demonstrate the ability to weld fillet welds in the 1F position using E4310, E4311, E4918, E4924 and E4928 electrodes.
3. Demonstrate the ability to weld fillet welds in the 2F position using E4310, E4311, E4914 and E4918 electrodes.
4. Demonstrate the ability to weld fillet welds in the 3F position using E4310, E4311, E4914 and E4918 electrodes.
5. Describe guided bend tests.
6. Demonstrate the ability to weld groove welds on butt joints in the 1G position, root pass using E4310 or E4311, and fill and cap using E4918 filler material.
7. Demonstrate the ability to weld groove welds on butt joints in the 1GF position using E4918 filler material complete with 1/4" backing plate.

E. Arc Cutting and Gouging (120102e).....3 Hours

Outcome: *Gouge and cut using carbon arc cutting with air process and observe plasma arc cutting.*

1. Describe the air carbon arc cutting process.
2. Observe air carbon arc cutting.
3. Describe the plasma arc cutting process and equipment.
4. Observe plasma arc cutting.
5. Demonstrate the ability to operate the air carbon arc cutting process.

SECTION THREE: GMAW, FCAW AND SAW73 HOURS**A. Gas Metal Arc Welding (GMAW) Equipment (120103a)4 Hours**

Outcome: *Select GMAW equipment.*

1. Describe the principles of operation of GMAW.
2. Identify the components of a basic GMAW set-up.
3. Describe the modes of metal transfer obtained with GMAW.
4. Describe GMAW power sources and wire feeders.
5. Describe GMAW wire drive systems and gun and cable assemblies.
6. Identify shielding gas supply systems for GMAW.

B. GMAW Filler Metals, Shielding Gases and Safety (120103b)4 Hours

Outcome: *Select GMAW consumables and apply safe work practices.*

1. Identify GMAW filler metals.
2. Identify shielding gases for GMAW.
3. Identify advantages and disadvantages of GMAW.
4. Identify the precautions you must take against electrical shock, toxic fumes and radiant energy associated with GMAW.

C. GMAW Equipment Maintenance and Troubleshooting (120103c)7 Hours

Outcome: *Set up, maintain and troubleshoot GMAW equipment.*

1. Describe and demonstrate the set-up and maintenance required for wire drive systems and gun assemblies.
2. Diagnose and demonstrate corrective measures for malfunctioning GMAW equipment.

D. Flux Cored Arc Welding (FCAW) (120103d)4 Hours**Outcome:** **Select and use FCAW equipment and consumables.**

1. Describe the principles of operation of FCAW.
2. Identify the components of a basic FCAW set-up.
3. Describe FCAW power sources, wire feeders and gun and cable assemblies.
4. Describe FCAW operating variables.
5. Identify shielding gases for FCAW.
6. Describe FCAW filler metals.
7. Describe FCAW equipment maintenance and troubleshooting.
8. Identify advantages and disadvantages of FCAW.

E. Submerged Arc Welding (SAW) (120103e)5 Hours**Outcome:** **Select SAW equipment and consumables.**

1. Describe the principles of operation of SAW.
2. Identify the components of a basic set-up.
3. Describe SAW power sources, wire feeders, flux feed systems, welding head assemblies and control systems.
4. Describe SAW operating variables.
5. Identify SAW filler metals and fluxes.
6. Describe SAW equipment maintenance and troubleshooting.
7. Identify advantages and disadvantages of SAW.

F. Shop / Lab Practices: GMAW Welds on Gauge and Thicker Mild Steel (120103f)30 Hours**Outcome:** **Perform surface welds in the flat and horizontal positions on mild steel plate.****Perform 1F position welds on mild steel.****Perform 2F position welds on mild steel.****Perform 3F position welds on mild steel.****Perform 1G position welds on mild steel.****Perform 2G position welds on mild steel.****Perform 3G position welds on mild steel.**

1. Demonstrate the ability to weld stringer/ weave beads in the flat and horizontal positions.
2. Demonstrate the ability to weld 1F welds on mild steel plate.
3. Demonstrate the ability to weld fillet welds in the horizontal (2F) position on mild steel plate.
4. Demonstrate the ability to weld fillet welds in the vertical (3F) position (downhill root and uphill fill and cover pass) on mild steel plate.
5. Prepare and fit up butt joints without backing.
6. Demonstrate the ability to weld butt joints in the 1G position.
7. Demonstrate the ability to weld butt joints in the 2G position.
8. Demonstrate the ability to weld butt joints in the 3G position.
9. Optional 4G position on 3/8" material.

G. Shop /Lab Practices: FCAW Welds on Mild Steel (120103g).....14 Hours**Outcome:** *Perform surface welds in the flat and horizontal positions on mild steel.**Perform 1F position welds on mild steel.**Perform 2F position welds on mild steel.**Perform 3F position welds on mild steel.**Perform 1GF position welds on mild steel.**Perform 2GF position welds on mild steel. (optional)**Perform 3GF position welds on mild steel. (optional)*

1. Demonstrate the knowledge to weld stringer/ weave beads in the flat and horizontal positions on mild steel plate.
2. Demonstrate the knowledge to weld 1F welds on mild steel plate.
3. Demonstrate the knowledge to weld fillet welds in the horizontal (2F) position on mild steel plate.
4. Demonstrate the knowledge to weld fillet welds in the vertical (3F) position on mild steel plate.
5. Prepare and fit up butt joints with backing.
6. Demonstrate or perform the knowledge to weld butt joints in the 1G position on mild steel plate.
7. Demonstrate or perform the knowledge to weld butt joints in the 2G position on mild steel plate.
8. Demonstrate or perform the knowledge to weld butt joints in the 3G position on mild steel plate.

H. Shop / Lab Practices: Combined GMAW and FCAW Welds on Mild Steel (120103h)..... 5 Hours

Labs may be integrated with section F and G.

Outcome: *Perform 1G, 2G, and 3G position welds on mild steel.*

1. Demonstrate the knowledge to weld butt joints in the 1G position on mild steel using GMAW for the root bead and FCAW fill and cap.
2. Demonstrate the knowledge to weld butt joints in the 2G position on mild steel using GMAW for the root bead and FCAW fill and cap.
3. Demonstrate the knowledge to weld butt joints in the 3G position on mild steel using GMAW for the root bead and FCAW fill and cap.

SECTION FOUR:TRADE PROBLEMS30 HOURS**A. Fractions (120104a)4 Hours****Outcome:** *Solve problems involving fractions.*

1. Identify key terms and concepts used in working with fractions.
2. Change fractions to a common denominator.
3. Solve problems using whole numbers and fractions.
4. Solve problems using whole numbers and fractions in practical applications.

B. Decimals (120104b).....4 Hours**Outcome:** *Solve problems involving decimals.*

1. Read and write decimal fractions.
2. Round decimal fractions to specified place values.
3. Convert decimal inches to a fraction with a practical denominator.
4. Convert decimal feet to feet and inches with a practical denominator.
5. Convert fractions to decimals.
6. Add and subtract decimal fractions.
7. Multiply and divide decimal fractions.

C. Percentage and Ratios (120104c).....5 Hours**Outcome:** *Solve problems involving percentage and ratios.*

1. Convert between fractions and percents.
2. Convert between decimals and percents.
3. Calculate ratio problems: two quantities in the form of a ratio and two ratios in the form of a proportion.
4. Solve percent problems.

D. Geometric Formulas (120104d)12 Hours**Outcome:** *Solve problems involving geometric formulas.*

1. Identify key terms and concepts used in working with formulas.
2. Identify common formulas and solve problems for perimeter.
3. Identify common formulas and solve problems for area.
4. Identify common formulas and solve problems for volume.
5. Calculate the weight of a solid.
6. Calculate the capacity of a container in gallons.

E. Metric and Imperial Measurement (120104e)5 Hours**Outcome:** *Solve problems involving metric and imperial measure.*

1. Identify commonly used metric units of measurement.
2. Convert between units of measurement.
3. Convert imperial units: feet to inches, square inches to square feet, and cubic measures to gallons.

**SECOND PERIOD TECHNICAL TRAINING
WELDER TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... SMAW TWO 110 HOURS

A. SMAW Groove Welds on Grey Cast Iron (120201a) 2 Hours

Outcome: *Describe cast iron welding using SMAW.*

1. Describe hot welding and cold welding of grey cast iron.
2. Identify the special problems in welding grey cast iron.
3. Identify electrodes for welding grey cast iron.
4. Describe joint preparation for grey cast iron.
5. Observe SMAW groove welds in the flat position (1G) on single vee butt joints on grey cast iron.

B. Production and Properties of Metals (120201b) 6 Hours

Outcome: *Identify the production processes and types of iron and steel.*
 Identify the mechanical and physical properties of metals.

1. Describe the production processes for iron and steel.
2. Describe the types of iron and steel.
3. Describe the mechanical properties of metals.
4. Describe the physical properties of metals.

C. Carbon and Alloy Steels and Alloy Steel Filler Metals (120201c) 8 Hours

Outcome: *Identify carbon steels and welding procedures.*
 Identify the effects of alloy content on the weldability of steel.
 Identify alloy steel filler metals.

1. List the carbon content and the uses for low carbon steel, medium carbon steel and high carbon steel.
2. Identify classification systems for steel.
3. Identify the effect of carbon content on the weldability of steel.
4. Identify the effects of elements on the properties of carbon steel.
5. Identify the major alloying elements in alloy steels.
6. Identify the types, properties and weldability of low alloy steels.
7. Identify the properties and weldability of high strength, low alloy steels (HSLA).
8. Identify alloy steel filler material classifications in the accordance with AWS and CSA specifications.
9. Identify commonly used low alloy steel filler metals and their applications.

D. Metal Identification (120201d) 2 Hours**Outcome: *Identify types of metal.***

1. Identify metals by visual appearance, colour, relative weight, typical shape and texture.
2. Describe chip testing, spark testing, file hardness tests, and flame tests.
3. Interpret information supplied on mill test reports.

E. Distortion (120201e) 3 Hours**Outcome: *Identify distortion and methods to control it.***

1. Identify how heat and temperature relate to distortion.
2. Identify the three types of distortion, their causes and control of each type.
3. Describe the mechanical, procedural and design methods of controlling distortion.

F. Hardfacing (120201f) 3 Hours**Outcome: *Observe hardfacing of steel.***

1. Describe the hardfacing process and applications.
2. Identify the types of wear.
3. Identify filler metals for hardfacing.
4. Identify the problems associated with hardfacing and how to avoid them.
5. Describe the procedures for applying hardfacing materials.
6. Observe hardfacing mild steel plate in the flat position.

G. SMAW Welds on Mild Steel (120201g)..... 86 Hours**Outcome: *Perform 3F (up and down) welds using SMAW.******Perform 4F welds using SMAW.******Perform 2G welds using SMAW.******Perform 3G welds using SMAW.******Perform 2G with backing welds using SMAW.******Perform 3G welds using SMAW with backing.***

1. Demonstrate the ability to weld lap joints in the 3F position uphill on 3/8" (10mm) mild steel using E4310 or E4311 and E4918 filler metals.
2. Demonstrate the ability to weld lap joints in the 3F position downhill on 1/4" (6mm) or less mild steel using E4310 or E4311 or E5510-G filler materials.
3. Demonstrate the ability to weld lap joints in the 4F position on 3/8" (10mm) mild steel using E4310 or E4311 and E4918 filler materials.
4. Demonstrate the ability to weld groove welds in the 2G position on 3/8" (10mm) mild steel using E4310 or E4311 for the root and E4918 for the fill and cap.
5. Demonstrate the ability to weld groove welds in the 2G position on mild steel single bevel plate with a backing plate using E4918 filler materials.
6. Demonstrate the ability to weld groove welds in the 3G position uphill on 3/8" (10mm) mild steel using E4310 or E4311 for the root and E4918 for the fill and cap.
7. Demonstrate the ability to weld groove welds in the 3GF position on 3/8" (10mm) mild steel with a backing plate using E4918 filler materials.

SECTION TWO: GTAW ONE GMAW AND FCAW TWO 64 HOURS

A. Introduction To The GTAW Process (120202a) 2 Hours**Outcome:** *Apply safe work practices and procedures when using GTAW.*

1. Describe the GTAW process and applications.
2. Describe advantages and disadvantages of the GTAW process.
3. Explain the hazards and protective measures associated with GTAW.
4. Identify the basic components of a GTAW workstation.
5. Describe types of GTAW power sources.
6. Identify welding currents used in GTAW, AC, DC and high frequency.
7. Describe the torch assembly.
8. Describe gas regulators and flow meters.

B. GTAW Electrodes, Filler Metals and Shielding Gases (120202b) 4 Hours**Outcome:** *Select GTAW electrodes.**Select GTAW filler metals and gases.*

1. Identify the function of the electrode in GTAW.
2. Identify electrodes by AWS designations and explain their applications.
3. Explain and demonstrate the care and preparation of electrodes.
4. Identify the function of the filler metals in GTAW.
5. Identify filler metals by AWS and CSA designations and explain their applications.
6. Identify types and purpose of consumable inserts.
7. Explain the care and handling of filler metals.
8. Describe the types and applications of shielding gases used in GTAW.
9. Describe the advantages and disadvantages of various shielding gases.

C. GTAW Equipment Maintenance And Troubleshooting (120202c) 3 Hours**Outcome:** *Troubleshoot and maintain GTAW equipment.*

1. Diagnose power source output current problems and demonstrate corrective measures.
2. Diagnose GTAW torch and cable assembly problems and demonstrate corrective measures.
3. Explain the care and handling of GTAW equipment components.
4. Diagnose shielding gas coverage problems and demonstrate corrective measures.

D. GTAW Welds on Mild Steel (120202d) 18 Hours**Outcome:** *Prepare joints for GTAW and perform welds in the 1F position.**Perform GTAW welds in the 2F position.**Perform GTAW welds in the 3F position.*

1. Strike an arc, using the touch start or lift start and high frequency methods.
2. Demonstrate the ability to weld stringer beads in the flat position on mild steel gauge plate.
3. Prepare joints for GTAW on mild steel gauge plate.
4. Demonstrate the ability to weld fillet welds in the 1F position on mild steel gauge plate.

5. Demonstrate the ability to weld fillet welds in the 2F position on mild steel gauge plate.
6. Demonstrate the ability to weld fillet welds in the 3F position on mild steel gauge plate.
7. Demonstrate the ability to weld butt welds on 1/4" or 3/8" plate, 1G, 2G, 3G on available pipe in the 2G, 5G, (Optional).

E. Aluminum and Aluminum Welding (120202e) 8 Hours

Outcome: *Explain basic aluminum GTAW principles.*

1. Compare the physical and chemical properties of aluminum and steel.
2. Explain how physical and chemical properties affect the welding of aluminum.
3. Explain the aluminum association numerical designation for wrought aluminum alloys.
4. Explain the aluminum association numerical designation for casting alloys.
5. Define the alloys and explain the effects of welding on heat treatable and non-heat treatable alloys.
6. List the preferred welding processes for joining of aluminum and its alloys.
7. List the used filler metals most commonly used for welding aluminum with GTAW and GMAW.

F. GTAW Welds on Aluminum (120202f) 6 Hours

Outcome: *Perform fillet welds on aluminum in the 1F position using GTAW.*
Perform fillet welds on aluminum in the 2F position using GTAW.
Perform fillet welds on aluminum in the 3F position using GTAW.

1. Demonstrate the ability to weld stringer beads in the flat position on aluminum gauge plate.
2. Demonstrate the ability to weld fillet welds in the 1F position on aluminum gauge plate.
3. Demonstrate the ability to weld fillet welds in the 2F position on aluminum gauge plate.
4. Demonstrate the ability to weld fillet welds in the 3F position on aluminum gauge plate.

G. GTAW Welds on Stainless Steel (120202g) 6 Hours

Outcome: *Perform GTAW welds in the 2F position with and/or without stainless steel fillers.*
Perform GTAW welds in the 3F position with and/or without stainless steel fillers.
Perform GTAW welds in the 4F position with and/or without stainless steel fillers.

1. Select filler metals used on stainless steel.
2. Select the welding procedure and welding current for GTAW on stainless steel gauge plate.
3. Demonstrate the ability to weld in the 2F position on stainless steel gauge plate.
4. Demonstrate the ability to weld in the 3F position on stainless steel gauge plate.
5. Demonstrate the ability to weld in the 4F position on stainless steel gauge plate.

H. GMAW Welds on Aluminum (120203) 2 Hours

Outcome: *Observe flat position welds on aluminum.*
Observe horizontal position welds on aluminum.
Observe vertical welds on aluminum.

1. Observe the ability to weld stringer/weave beads in the flat and horizontal positions on 1/8" (3.2mm) or greater aluminum material.
2. Observe welding in the 1F position on 1/8" (3.2mm) or greater aluminum material.
3. Observe stringer/weave beads in the horizontal position on aluminum plate.

4. Observe welding in the 2F position on aluminum plate.
5. Observe welding in the 3F position on aluminum plate.

I. GMAW and FCAW Welds on Mild Steel Pipe (120203)..... 15 Hours

Outcome: *Perform GMAW 2G welds on mild steel pipe.
Perform FCAW 1G roll and 2G welds on mild steel pipe using a GMAW root pass and FCAW fill and cap (Optional).
Perform GMAW 5G welds on mild steel pipe.*

1. Demonstrate the ability to weld in the 2G position on available pipe using GMAW.
2. Demonstrate the ability to weld in the 1G-rotated position on available pipe using a GMAW root pass and FCAW fill and cap.
3. Demonstrate the ability to weld in the 2G position on available pipe using a GMAW root pass and FCAW fill and cap.
4. Demonstrate the ability to weld with GMAW in the 5G position on available pipe root pass downhill; fill and cap uphill.

SECTION THREE: PATTERN DEVELOPMENT AND DRAWING INTERPRETATION..... 66 HOURS

A. Introduction to Pattern Development (120204a)..... 6 Hours

Outcome: *Identify lines, drawings and drawing equipment.*

1. Identify and use the alphabet of lines.
2. Describe the principles of scale drawings.
3. Identify perspective, oblique and isometric drawings.
4. Describe the principles of oblique and isometric drawings.
5. Describe the principles of orthographic projection.
6. Sketch simple objects in orthographic projection.
7. Identify SI metric and imperial dimensioning.
8. Describe size, location and notation dimensions:
 - a) aligned
 - b) unidirectional
 - c) base line / datum line
 - d) angular
 - e) curved surfaces
 - f) tolerance
9. Develop a fully dimensioned orthographic drawing to scale.

B. Geometric Construction (120204b)..... 14 Hours

Outcome: *Perform basic geometric construction.*

1. Describe and use T-squares, set squares, the compass, rulers and pencils.
2. Identify and name the various parts of a circle.
3. Use a compass and straightedge to bisect lines, angles and arcs.
4. Use a compass and straightedge to construct a perpendicular.
5. Construct a 90° and 60° angle using a compass.
6. Divide a line into equal parts.

7. Divide a circle into equal parts.
8. Locate the center of a circle.
9. Sketch a cover plate.
10. Develop patterns for various plate components.

C. Isometric and Oblique Drawings (120204c) 6 Hours

Outcome: *Develop basic isometric and oblique drawings.*

1. Draw isometric and oblique drawings of basic rectangular objects.
2. Draw isometric and oblique drawings of basic objects with circular features.

D. Basic Fabrication Layout Practice (120204d) 10 Hours

Outcome: *Describe accepted layout procedures.*

1. Define or describe various symbols and abbreviations used in material mark-up.
2. Describe plate layout tools.
3. List and describe the purpose for various types of markers.
4. Describe mark-up procedure for flame cutting, drilling, punching, rolling (forming), breaking, shearing and match-marking.
5. Describe the use of templates.
6. List types of materials used to make templates.
7. Record information required on templates.

E. Plate Layout (120204e) 8 Hours

Outcome: *Develop basic plate layouts.*

1. Explain how to establish a square corner when laying out large or square shapes.
2. Describe the recommended procedure for efficient plate utilization (nesting).
3. Layout the bolt holes for a flange.
4. Develop a pattern for an elliptical opening.
5. Draw patterns from an orthographic drawing for a cone and hopper.
6. Develop patterns for various plate components.
7. Calculate the angle of cut and lengths for various plate components.
8. Mark plate according to calculated dimensions.

F. Pipe Layout (120204f) 6 Hours

Outcome: *Perform basic pipe layouts.*

1. Identify pipe sizes, and schedules.
2. Describe pipe layout tools.
3. Develop patterns for various pipe fabrications.
4. Calculate the angle of cut, measure back, and length of pieces for various pipe turns.
5. Mark out pipe using a wrap around to calculated dimensions.

G. Welding Symbols (120204g) 10 Hours**Outcome:** *Interpret welding symbols.*

1. Explain the purpose of welding symbols.
2. Define weld symbol, welding symbol, and supplementary symbols.
3. Draw and interpret basic weld symbols, and welding symbols.
4. Identify the dimensioning of weld symbols.
5. Identify non-destructive testing symbol.

H. Estimating (120204h) 6 Hours**Outcome:** *Conduct an estimate for a project.*

1. Convert angular (degree) measurements to linear measurements.
2. Calculate the cost of steel sections given the price per unit weight.
3. Estimate total costs for a given project.

**THIRD PERIOD TECHNICAL TRAINING
WELDER TRADE
COURSE OUTLINE**

UPON SUCCESSFUL COMPLETION OF THIS PROGRAM THE APPRENTICE SHOULD BE ABLE TO PERFORM THE FOLLOWING OUTCOMES AND OBJECTIVES.

SECTION ONE:..... SMAW THREE 118 HOURS

A. Stainless Steel (120301a)..... 6 Hours

Outcome: *Identify stainless steels and welding procedures.*

1. Describe stainless steel.
2. List the three major types of stainless steel and their properties.
3. Identify the appropriate AISI numbering system of stainless steel.
4. Explain carbide precipitation and list ways of overcoming this problem.
5. Identify the major types of stainless steel filler materials and AWS specifications.
6. Describe proper handling and storage of stainless steel electrodes and filler materials.
7. Explain the handling procedures and preparation for welding stainless steel.

B. Nickel Alloys and Clad Steels (120301b)..... 2 Hours

Outcome: *Identify nickel alloys and welding procedures.*
 Identify clad steels and welding procedures.

1. Describe nickel and its alloys.
2. Demonstrate the ability to locate and select appropriate filler metals in AWS specifications.
3. Explain welding procedures for nickel alloys.
4. Explain common weld faults and how to overcome these when welding nickel alloys.
5. Describe clad steels and list their advantages.
6. Explain preparation and welding procedures for clad steels.

C. SMAW Welds and Oxy-fuel Cutting on Mild Steel (120301c) 80 Hours

Outcome: *Perform SMAW welds in the 1G position.*
 Perform SMAW welds in the 2G position.
 Perform SMAW welds in the 45° overhead position.
 Perform SMAW welds in the 4G position.
 Perform SMAW welds in the 4G position with backing.
 Perform Oxy-fuel cutting.

1. Demonstrate the ability to weld butt joints in the 1G position on 9.6 mm (3/8") mild steel using E4310 or E4311 filler material for the root pass and E4918 for each sequential pass.
2. Demonstrate the ability to weld in the 2G position on 9.6 mm (3/8") mild steel using E4310 or E4311 filler material for the root pass and E4918 for each sequential pass.
3. Demonstrate the ability to weld butt joints in the 45° overhead position on 9.6 mm (3/8") mild steel using E4310 or E4311 filler material for the root pass and E4918 for each sequential pass.
4. Demonstrate the ability to weld butt joints in the 4G position on 9.6 mm (3/8") mild steel using E4310 or E4311 filler material for the root pass and E4918 for each sequential pass.

5. Demonstrate the ability to weld butt joints in the 4G position on 9.6 mm (3/8") mild steel plate with backing according to CSA Standard W47.1.
6. Perform oxy-fuel bevel cutting on available mild steel.
7. Pierce and cut a wide flange structural shape opening in mild steel plate (optional).

D. SMAW Groove Welds on Mild Steel Pipe (120301d) 30 Hours

Outcome: *Perform SMAW welds in the 2G-5G position.*
 Perform SMAW welds in the 5G position downhill.

1. Prepare, fit up and tack weld pipe for SMAW.
2. Demonstrate the ability to feather tack welds.
3. Identify the pipe welding positions.
4. Demonstrate the ability to weld butt joints on 6" schedule 80 pipe in the 2G, 5G positions using an E4310 or E4311 root and E4918 fill and cap.
5. Demonstrate the ability to downhill weld butt joints on available pipe in the 5G position.

SECTION TWO: GTAW TWO 28 HOURS

A. GTAW Welds Mild Steel Plate and Pipe (120302a) 28 Hours

Outcome: *Perform GTAW welds in 1G position.*
 Perform GTAW welds in 2G position.
 Perform GTAW welds in 3G position.
 Perform GTAW welds in 2G and 5G on available pipe.

1. Demonstrate the ability to weld in the 1G position on 6.4 m (1/4") mild steel plate.
2. Demonstrate the ability to weld in the 2G position on 6.4 m (1/4") mild steel plate.
3. Demonstrate the ability to weld in the 3G position (uphill) on 9.6 mm (3/8") mild steel plate and E4918 for each sequential pass.
4. Prepare and fit-up for GTAW.
5. Demonstrate the ability to weld in the 2G position on available mild steel pipe using stainless steel filler metals.
6. Demonstrate the ability to weld in the 5G position on available mild steel pipe using stainless steel filler metals.
7. Demonstrate the ability to weld in the 6G position on available mild steel pipe using carbon steel filler metals.

SECTION THREE: DRAWING INTERPRETATION 58 HOURS

A. Introduction to Drawing Interpretation (120303a) 12 Hours

Outcome: *Read and interpret drawings.*

1. Explain the purpose of drawings.
2. Identify elements and information found on drawings.
3. Interpret symbols used in drawings.
4. Recognize and interpret abbreviations used on drawings.
5. Identify site plans, benchmarks and orientation.

B. Structural Drawings (120303b)..... 14 Hours**Outcome:** *Interpret structural drawings.*

1. Identify structural shapes and how they are specified.
2. Identify types of structural drawings.
3. Obtain dimensions and other information from drawings.
4. Reference bill of materials for drawings.
5. Interpret a drawing in order to lay out, assemble and weld the components.

C. Piping Drawings (120303c)..... 16 Hours**Outcome:** *Interpret piping drawings.*

1. Define and explain the purpose of a spool sheet.
2. Identify single-line and double-line drawings.
3. Interpret symbols that represent individual components on a spool sheet.
4. Interpret relative position and orientation of piping systems from an isometric drawing.
5. Interpret component sizes in a piping system from a spool sheet.
6. Draw sketches of piping assemblies in schematic form from an isometric drawing.
7. Compile a material list for a simple piping system.

D. Pressure Vessel Drawings (120303d)..... 16 Hours**Outcome:** *Interpret pressure vessel drawings.*

1. Describe and identify external and internal vessel components.
2. Interpret vessel drawings.
3. Identify material compositions as per code requirement on mill certification.

SECTION FOUR: TRADE SCIENCE. 36 HOURS**A. Non-Destructive Testing (120304a)..... 4 Hours****Outcome:** *Identify the types and uses of non-destructive testing methods.*

1. Identify various non-destructive tests.
2. Describe visual inspection techniques.
3. Describe hydrostatic tests.

B. Destructive Testing (120304b)..... 8 Hours**Outcome:** *Identify the types and uses of destructive testing methods.*

1. Identify types of destructive tests.
2. Describe the advantages and disadvantages of destructive testing methods.
3. Describe methods of conducting guided bend tests and the test results required of a sound weld.
4. Describe tensile testing and calculate the results of a tensile test.
5. Describe hardness testing.

C. Metallurgy (120304c) 7 Hours**Outcome:** *Describe the grain structure of carbon steels.*

1. Describe grain structure in metals, pure iron, slowly-cooled carbon steels, and rapidly-cooled carbon steels.
2. Describe dendritic grain growth.
3. Identify space-lattice types in metals.
4. Identify changes in grain structure that result from welding.

D. Heat Treatment (120304d) 6 Hours**Outcome:** *Identify the effects of heat treatment on carbon steels.*

1. Define heat affected zones in metals.
2. Explain the difference between heat and temperature.
3. Explain three forms of heat transfer.
4. Describe the effects of expansion and contraction.
5. Describe the purpose and effects of preheating and postheating.
6. Define stress relieving, normalizing, annealing, hardening, tempering and quenching and their effects on mechanical properties.
7. Observe and explain the principle of temperature indicating crayons and other temperature indicating devices.

E. Codes and Standards (120304e) 10 Hours**Outcome:** *Identify and adhere to welding codes, standards and specifications.*

1. Define the terms "code", "standard" and "specification".
2. Identify the advantages of standardization.
3. Identify agencies that set codes and standards.
4. Identify the codes that govern the welding in Canada for structural steel, boilers and pressure vessels, piping systems, pipelines and transmission systems and storage tanks.
5. Describe the welding procedure qualification.
6. Describe the welder performance qualification.
7. Describe the use of p-numbers, f-numbers and a-numbers in the ASME code.

F. Apprenticeship and Industry Training Board - Industry Network (650401a) 1 Hour**Outcome:** *Describe the role of the Alberta Apprenticeship and Industry Training Board and the network of industry committees.*

1. Describe Alberta's apprenticeship and industry training system.
2. Describe the roles and responsibilities of the Alberta Apprenticeship and Industry Training Board, government and post-secondary institutions.
3. Describe the roles and responsibilities of the PAC'S, LAC'S and occupational committees.





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